

Comparison of Digital Detectors for Integration into a Diffraction Enhanced Imaging System

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Abstract No. Kiss1282

Beamline(s): X15A

Introduction: Three detector systems have been characterized to determine their relative strengths and weaknesses for quantitatively recording x-ray images. Recent development in diffraction enhanced imaging (DEI)^{1,2,3} have initiated a study to characterize digital detectors being considered for integration into a synchrotron-based mammographic research program, as well as for a proposed clinical prototype for DEI-based mammography. The three systems were compared with respect to their format, dynamic range, and spatial resolution at 20 keV.

Methods and Materials: The detectors used in the study were a Fuji BAS 2500 Image Plate Reader, a prototype CCD from Mar USA, and a MicroPhotonics XQUIS 1000 CCD. Dynamic range was measured by imaging a Lucite step wedge. This indicated the saturation level as well as the linear response region of each detector that were used in calculating the dynamic range. The spatial resolution was determined by imaging an opaque object (Pb tape) with horizontal and vertical straight edges. This was used to measure the line spread function (LSF) and the modulation transfer function (MTF) in both the horizontal and vertical directions.

Results: The dynamic range for the Fuji system was 5.5×10^5 using a sensitivity setting of 4000 and a latitude setting of 5 for the reader. The Mar system's dynamic range was 6.4×10^4 at an exposure of 1 second, and the MicroPhotonics' dynamic range was 1.5×10^3 at an exposure of 1 second. Figure 1 shows the MTFs for the three detectors. The Mar CCD had a larger pixel size than the other two detectors ($64.4 \mu\text{m}$ compared to $50 \mu\text{m}$) and therefore its Nyquist frequency is lower.

Conclusions: The three detectors had comparable image quality. Each detector exhibited strengths and weaknesses relative to each other. The Fuji system had a large active area ($250 \times 200 \text{ mm}^2$) and dynamic range, making it very useful for medical applications, but is limited by a slow readout. The MicroPhotonics CCD had excellent spatial resolution and a very fast readout. But it also had the smallest active area ($51.2 \times 51.2 \text{ mm}^2$) and the smallest dynamic range. The Mar CCD also had a very fast readout and good spatial resolution. The study did not result in a choice for a detector system for integration, but it has provided an indication of certain performance standards for such a detector.

Acknowledgments: This work was supported in part by US Army Grant DAMD 17-99-1-9329.

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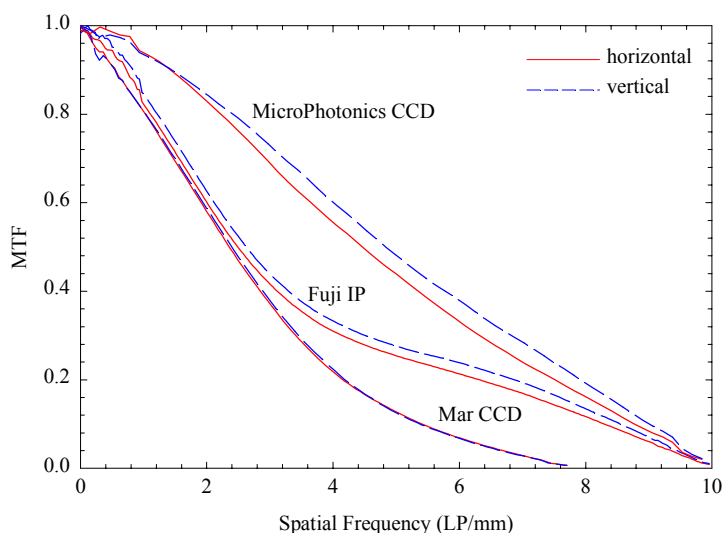


Figure 1. Comparison of MTF for three detectors. Data for the Mar CCD extends out only to about 8 LP/mm since it has a lower Nyquist frequency than the other two detectors.